The records of thunder and hailstorms in New South Wales up to the end of 1878 were examined by Mr. H. C. Russell, with reference to the risk from hail to the Exhibition Building erected in 1879. The list is given in this volume. Mr. Russell could not trace any period in those storms, except that they seemed more numerous in the first year after a drought. They are not severe or numerous in wet years. The great number of storms when the earth is passing through the November meteor stream is noted.

The so-called salt-bushes of Australia are known to have properties that are of great advantage to sheep, which relish and fatten on the food, especially in times of drought. Mr. Dixon has analysed some eight of those fodders of the Riverina district, and shows, by comparison with well-known European fodders, that they stand well as to nutritive value. One is struck with the extraordinary amount of ash. In seven of the eight, the average ratios of total ash, potash, and common salt to digestible matter (oil, carbohydrates, and albuminoids), taken as 100, are 47, 9·538 and 7·689 respectively; and the difference here from European fodders is conspicuous. Cotton bush (the eighth examined) ranks with the latter. Only two contain a very large proportion of common salt, viz. oldman salt bush (the most prized by graziers), has 15·403, in the relation just specified, and small salt bush, 14·590. While digestion is doubtless promoted by the soluble chlorides, it is in the wool that the greatest effect of the diet (so rich in potash) might be expected, and the high esteem in which Riverina wool is held, is a verification of this.

Various kinds of coal of New South Wales have been subjected to analysis by Mr. Dixon and by Prof. Liversidge, the latter of whom specially wished to see how they compared with our coals. He found the Northern District coals to contain least ash, average percentage 4·61; those of the Western District have 10·44 per cent.; and those of the Southern 10·99. Thus some of the Northern coal is quite equal in this respect to the Welsh and Scotch coals, and but little inferior to the English Newcastle coal. The quantity of sulphur in New South Wales coal is by no means excessive. Prof. Liversidge also furnishes an account of some minerals from New Caledonia, including the nickel-bearing *Noumeaite*. This mineral seems to be completely amorphous; the mass splits up into smooth concave-convex pieces like petals of an unopened bud. It is in some cases soft and brittle, and in others hard and tough enough to be cut into ornaments. The colour varies from the palest tinge of green to full rich malachite green. The composition ranges from practically pure hydrated silicate of magnesia to what is also practically only hydrated silicate of nickel. The earthy cobalt ore (asbolite) from New Caledonia differs considerably from those met with in other places; baryta is entirely absent, but magnesia seems to have taken its place in some cases.

An interesting paper by Dr. Manning, medical superintendent of the Hospital of the Insane at Gladesville, treats of the causes of insanity in 3077 patients admitted to that institution in ten years from 1869; a comparison being also drawn with English statistics. We note that 3·9 per cent. of the cases of insanity are attributed to isolation and nostalgia conjointly (a category not given in the English table). The cases of pure nostalgia were those of foreigners, who spoke English most imperfectly. The cases of isolation included shepherds, whose occupation some years ago was most lonely, and still is, in some places, though the state of things is improving in this respect. Dr. Manning found last year that more than one half (1038 out of 2036) of the inmates of those institutions in the colony were apparently quite friendless, and that 10 per cent. were foreigners. The isolation, which is something terrible to a new emigrant, and which lasts often for years, is kept up by the disparity of the sexes, which at the close of 1879 stood at 409,665 males and 324,617 females, and it is fostered by the peculiar shifting and restless life of the miners and the bushmen. Dr. Manning thinks the insanity from intemperance has been exaggerated; the percentage at Gladesville is 8·3. The vile quality of the drink (he considers) and the system of drinking (short reckless outbursts, with prolonged periods of abstinence), are prominent factors in the result. Sunstroke, as might be supposed, causes insanity to a much greater extent in New South Wales than in England; 5 per cent. of the cases are accredited to it. Dr. Manning also expresses the opinion that insanity through lactation prolonged beyond the ordinary time is more frequent. Again, he is struck with the number of cases admitted with symptoms of dyspepsia and "chronic ill health," and he attributes a considerable number of those to the want of varied and properly cooked meals. As to hereditary transmission of insanity, the Gladesville statistics give only 7·2 per cent., but they are much less complete than the English, owing to the difficulty of getting to know the family history.

We can do no more than briefly indicate some of the other subjects dealt with in this volume; some new double stars, the longitude of Sydney Observatory, the opposition and magnitudes of Uranus and Jupiter, the orbit elements of Comet I. 1880, changes in the surface of Jupiter, catalogue of plants collected by Forrest in North-West Australia, fossil flora of Eastern Australia and Tasmania, pituric, iron acted on by seawater, wood inclosed in basalt, fossils from Palæozoic rocks of New South Wales, schemes of water supply for Sydney, wells in the Liverpool plains.

ON THE APPLICATION OF PHOTOMETRY IN THE STUDY OF THE PHENOMENA OF DIFFUSION IN LIQUIDS

§ 1. SINCE the publication in 1803 of Berthollet's work,[1] in which it is already asserted that the diffusion of salt solutions in water takes place according to the same laws as the propagation of heat in solids, an exact method has frequently been sought for determining the coefficient of diffusion. The attempts in this direction have failed to give concordant results, which may best be judged from a compilation of the numbers expressible in absolute units with reference to chloride of sodium, whose coefficient of diffusion in water has most frequently been measured. The coefficient is stated to be—

$$\left.\begin{array}{lr} \text{By Graham, at } 5^\circ \text{ C. } \dots \dots \dots & 88 \\ \text{,, } \quad 9^\circ \text{ C. } \dots \dots \dots & 105 \\ \text{By Fick } \dots \dots \dots \dots \dots \dots & 116 \\ \text{By Johannisjanz } \dots \dots \dots \dots & 53 \\ \text{By Schuhmeister, at } 10^\circ \text{ C. } \dots \dots & 97 \end{array}\right\} \times 10^{-7} \cdot \frac{\text{cm}^2}{\text{sec.}}$$

When we inquire into the laws which govern this coefficient we meet with even greater discrepancies. Thus Graham, Fick, and Schuhmeister's researches indicate the increase of the coefficient with the rise of temperature. Johannisjanz finds no such relationship. Thus H. F. Weber, experimenting with sulphate of zinc, concludes that the coefficient of diffusion decreases with increase of concentration. Schuhmeister asserts exactly the contrary.

The importance which diffusion has gained of late as a means of investigating and solving many problems connected with molecular physics[2] induced me to search for a method which should permit me to investigate the processes of diffusion, not alone with more accuracy than heretofore in that direction in which the final results may be ascertained by simple weighing, but also to open up a new field of research which has been inaccessible up to now for want of suitable methods. A detailed description of my method, and a full account of all the circumstances to be observed in carrying out the experiments, will be found in *Wiedemann's Annalen*, vol. xiii. pp. 606–23. I will only give here the general outlines.

In the middle of a large glass trough a glass dish is inverted. On the top of this dish a narrow but thick glass rod is placed horizontally, and upon this four cylindrical vessels of approximately equal height at suitable distances from each other and from the walls of the trough. These are filled with solutions of the salt to be investigated, in such a way that the meniscus attains its maximum height. Water is now poured into the trough till it reaches in height 0·1 cm. below the edge of the shortest cylinder, and the whole allowed to stand for several hours to equalise the temperature. After this, by means of a specially constructed funnel, more water of exactly the same temperature as the water in the trough is introduced, until it reaches a height of several millimetres above the edge of the cylinders.

The apparatus is now left to itself.

To interrupt the experiment a method has been devised, the description of which will also be found in *Wiedemann's Annalen*.

The result is calculated by the formula—

$$D = \frac{r^2\pi}{4}\left(1 - \frac{c_2}{c_1}\right)^2 \cdot \frac{1}{t},$$

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[1] Berthollet, "Essai de statique chimique." Paris, 1803. vol. i., pp. 409–429.

[2] See Wroblewski, "On the Nature of the Absorption of Gases," in NATURE, vol. xxi. p. 100.

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where signify
l the depth of the cylinder.
t the time of the experiment.
c_1 the concentration of the salt solution before the experiment.
c_2 the mean concentration of the solution after the experiment.
D the coefficient of diffusion.

§ 2.—Chloride of sodium was the substance experimented with to test the method. Three solutions were prepared, of which the first contained 0·66487, the second 5·8506, and the third 17·695 parts by weight of the anhydrous salt in 100 parts of the solution. The cylinders employed were 2 to 8 cm. in diameter, and 3·45 to 5·036 cm. in depth. The experiments were conducted either in such a way that all the cylinders were filled with the same solution, and the observation made if the cross-cut and the depth of the cylinder had influenced the final result; or else differently concentrated solutions were taken, and the experiment carried out at exactly the same temperature and under the same other conditions. The method was found to be sensitive and accurate. The temperature being 8·5° C., and the duration of the experiment 6·5 hours, the coefficient found was:—

$$\left.\begin{array}{lllr}\text{With a solution of } 0{\cdot}66487 & \text{per cent.} & \ldots & 768\\ \quad\;\;,, \qquad ,, \quad 5{\cdot}8506 & \quad ,, & \ldots & 808\\ \quad\;\;,, \qquad ,, \quad 17{\cdot}695 & \quad ,, & \ldots & 889\end{array}\right\}\times 10^{-8}\,\frac{\text{cm}^2}{\text{sec.}}$$

The conclusion to be drawn from these numbers is that coefficient of diffusion within the limits of time and concentration indicated decreases according to the law of the straight line as the quantity of salt in solution.

From this result follow:—

1. The numerical value of the coefficient at the same temperature, and the same initial concentration depends upon the duration of the experiment.

2. A fixed state, in which the concentrations in the fluid decrease from bottom to top, according to the law of the straight line, is impossible. Fick's method, which presupposes this state, cannot therefore give correct results.

From the above-mentioned law of the dependence of the coefficient of diffusion on the quantity of salt in solution, and from the first conclusion, it follows that at one and the same temperature the value of the coefficient may vary between two widely separated limits. An experiment performed with a saturated solution during the shortest possible time would furnish the one limit, another with a solution containing a quantity of salt approximating to zero would give the other.

The physical cause and the necessity for the mentioned dependence is very simple. If a volume of water be mixed with one volume of concentrated salt-solution, and if a volume of water be mixed with a volume of dilute salt-solution, the resulting contraction in the first instance is greater than in the second. The diffusion of a salt-solution in water has been up to the present considered from a very one-sided point of view. Berthollet and Fick ascribe the diffusion to the forces alone which act between water and salt-solution; modern investigators ascribe it solely to the molecular velocity of the fluid molecules. The experiment shows that the diffusion depends on both, and therefore supports neither of these views entirely. When the cylinder has been filled with concentrated solution the participation of the molecular forces is greater than in the case of weak solution. The numerical value of the coefficient of diffusion, which expresses the result of the experiment, must necessarily be greater in the first case than in the latter. It is therefore in our power to regulate the phenomena of diffusion in a salt solution according to our will; thus when we experiment with concentrated solutions the principal agents at work are the molecular forces, whilst the velocity of the molecules plays the chief part in dilute solutions. The coefficient of diffusion of a salt-solution loses, therefore, entirely the signification of a constant, because in every special case it has another value.

§ 3. The coefficients of diffusion of salt solutions in water at the temperature of 10° C., determined by Graham, Fick, Weber, and Schuhmeister, form a group of numbers which lie between 0·000010 and 0·000002 $\frac{\text{cm}^2}{\text{sec.}}$.

It was of great interest to ascertain the value of the coefficient of diffusion when the quantity of salt is so small that it can neither be estimated with the balance nor with chemical means; when, in short, the solution differs hardly at all from pure water, and when the participation of molecular forces has been brought to a minimum. Such an experiment may be made by tinting water with a salt of great tinctorial power and observing the diffusion of the coloured water into the pure. It is much more difficult to follow these experiments quantitatively, as very small quantities have to be determined. Colorimetrical methods are not sensitive enough.

I therefore tried to measure the concentration photometrically. Nigrosin, which is sufficiently stable towards sunlight, was the colouring matter chosen for the purpose. Hüfner's spectro-photometer was employed. The water was coloured with nigrosin to such an extent that its coefficient of extinction for sodium light amounted to 1·343. The quantity of colouring matter used was so small that the change of specific gravity in the water through its addition could not be ascertained.

A full report of the many difficulties which were encountered and a detailed description of how the experiments were conducted will be found in the above mentioned *Wiedemann's Annalen*. It was discovered that the coefficient of diffusion was smaller by one decimal place than the smallest known coefficient of a salt.

The method here described urges the investigation of a series of new problems.

In the first place the value of the coefficient must be ascertained for different salts when the salt in solution approximates zero. When these values have been found, only then it will be possible to define in what way the coefficient of diffusion depends on the nature of the salt.

Secondly, it is necessary to find out if it is not possible, by tinting water with different colouring-matters, to obtain a constant, which I propose—analogously to a case already considered by J. Clerk Maxwell—to call *the coefficient of diffusion of a fluid into itself*.

If we suppose a room to be divided into two parts by a movable wall and filled with the same gas at the same pressure and temperature, and we then remove the wall, a diffusion of the gas takes place from the one half of the room to the other, and *vice versâ*, in consequence of molecular velocity. The coefficient of the diffusion which takes place here, Maxwell calls *the coefficient of diffusion of a gas into itself*. It is not measurable, as the molecules of a gas cannot be marked. It can however be calculated from the coefficient of viscosity of this particular gas kinematically measured by multiplying by 1·5435.

When salt-solution diffuses, it is not the salt, but the salt-solution, which diffuses into water. The more dilute the solution, the nearer that state is approached in which pure water diffuses into pure water. How near I have approached this state in my experiments with nigrosin I have no means at present to judge. I have no doubt however that this is the only method of ascertaining the coefficient, which, if once determined in similar manner for every fluid, will be of eminent importance to a kinetic theory of fluids, which has yet to be built up. It is only necessary to bear in mind the assistance rendered to Maxwell by the determination of the coefficients of diffusion of gases by Loschmidt.

S. WROBLEWSKI

THE ROTATIONAL CO-EFFICIENT IN VARIOUS METALS

THE following is an abstract of a Note on the above subject read by Prof. E. H. Hall at the meeting of the British Association at York.

It was discovered two years ago in Johns Hopkins University that when a conductor carrying a current is placed in a magnetic field, the direction of whose force is perpendicular to the current, the current is deflected at right angles to the force and to the original direction of the current. A slip of gold leaf on glass was placed between the poles of Faraday's electro-magnet, with the faces of the gold-leaf perpendicular to the lines of force. Wires were attached one at each end of the strip, for the purpose of transmitting a current through it, and two other wires were led from the middle points of the sides of the strip to a Thomson's galvanometer. When the electro-magnet was not made this galvanometer showed no deflection, but on sending a current through the coil of the electro-magnet a deflection was obtained, and on reversing the direction of this current the deflection was reversed.

Dr. Hopkinson has pointed out that Maxwell, in the first part of his book, treating this subject in the most general way, allows the possibility that something of this kind may take place. Maxwell suggests the name "rotational coefficient"; so the

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